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Mr. Ronald Repasi
Deputy Chief, Office of Engineering and Technology
Federal Communications Commission
445 12th Street SW
Washington, DC 20554

In Re: WT Docket No. 07-293 (Amendment of Part 27 of the Commission's Rules to Govern the Operation of Wireless Communications Services in the 2.3 GHz Band); IB Docket No. 95-91 (Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band)

Dear Mr. Repasi:

During our most recent meeting to discuss interference to satellite radio from mobile transmissions in the WCS band,¹ Sirius XM offered to file additional technical detail on recommended rules that would allow these services to co-exist without creating significant interference to satellite radio subscribers. The following presentation supplies these details.

I. Introduction

On July 28 and 29, 2009, Sirius XM, FCC technical staff and a subset of WCS licensees conducted a series of tests and demonstrations in Ashburn, Virginia, to evaluate the susceptibility of Sirius XM receivers to transmissions from mobile devices operating on WCS frequencies.² The Ashburn tests confirmed that destructive interference to

¹ See Letter from Michael A. Lewis, Engineering Consultant, Wiley Rein, LLP, Counsel for Sirius XM Radio Inc. to Marlene H. Dortch, Secretary, Federal Communications Commission, WT Docket No. 07-293 (submitted December 1, 2009).

² See Letter from Terrence R. Smith, Corporate Vice President and Chief Engineering Officer, and James S. Blitz, Vice President, Regulatory Counsel, Sirius XM

satellite radio service will result from unrestricted mobile WCS transmissions. For example, the tests have shown that mobile WCS devices operating in conformance with the WCS Coalition's proposals cause the complete loss of satellite radio reception (*i.e.*, muting) when located within 28 meters of a satellite radio receiver.³ On the other hand, the participating WCS licensees demonstrated that WCS mobile devices operating under certain conditions and technology-specific transmission parameters could transmit without causing complete loss of satellite radio reception.⁴

Since the conclusion of the Ashburn tests, Sirius XM has focused on ways the Commission could accomplish the dual public interest goals of protecting service to more than 18 million current satellite radio subscribers while enabling compatible mobile broadband deployments in the WCS bands. These goals cannot be achieved by simply relaxing the out-of-band emissions ("OOBE") limits for mobile WCS transmitters, as the WCS Coalition suggests.⁵ The Ashburn tests, among other things, definitively showed that reducing mobile OOBE without addressing other operating parameters – such as frequency block of operation, duty cycle, transmitter power, and WCS antenna placement – would have a devastating impact on the quality of satellite radio reception.⁶ These parameters need to be addressed in comprehensive fashion because they are all interrelated in terms of how they impact the potential interference that would be created by mobile WCS devices.

Sirius XM has previously pointed out that current WCS rules allow the allocation to be used productively for a variety of critical broadband applications, including providing fixed consumer services and backhaul. While satellite radio can co-exist with mobile broadband applications in at least some WCS spectrum blocks under the terms outlined herein, the laws of physics prevent this band from ever becoming the functional equivalent of other allocations dedicated for commercial mobile broadband services, such as the Broadband PCS, AWS, 700 MHz, and BRS bands. The 2.3 GHz band presents unavoidable challenges owing to the fact that the various services allocated within the band – with both satellite and terrestrial uses – are potentially highly incompatible. *In*

Radio Inc. to Ms. Marlene H. Dortch, Secretary, Federal Communications Commission, IB Docket No. 95-91, WT Docket No. 07-293 (submitted August 3, 2009) ("Sirius XM August 3 Ex Parte").

³ *Id.*

⁴ *Id.* at 5. Sirius XM has explained that its digital satellite streams can potentially suffer significant data loss from WCS interference before a complete loss of satellite service (*i.e.*, "muting").

⁵ *See Ex Parte* Letter from Paul J. Sinderbrand, Counsel to the WCS Coalition, to Marlene H. Dortch, Secretary, Federal Communications Commission at 10, 12-13, IB Docket No. 95-91, WT Docket No. 07-293 (submitted December 10, 2009).

⁶ Sirius XM August 3 Ex Parte at 4 ("Sirius XM proved how different mobile WCS configurations and use cases – cases that would be allowed under the WCS Coalition's proposed rules – cause devastating interference to satellite radio reception even at extreme separation distances and even in the presence of a terrestrial repeater.")

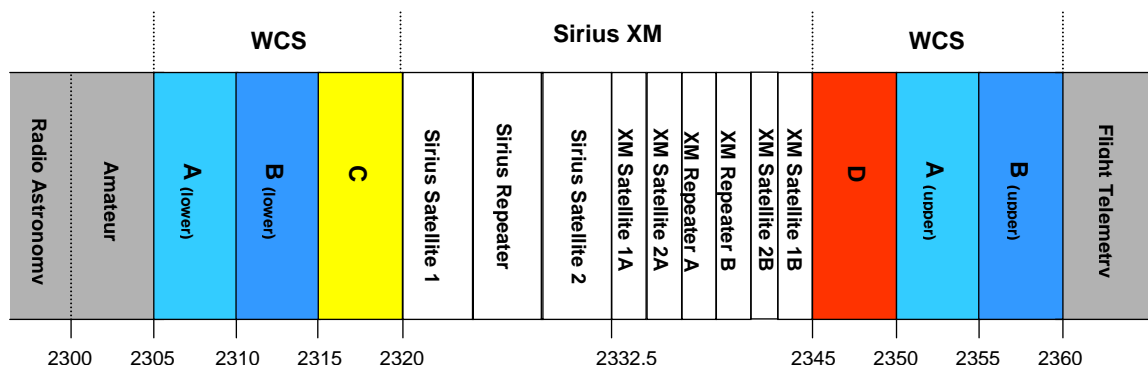
fact, what the WCS Coalition proposed is literally unprecedented: there is no other example in the U.S. spectrum allocations table where the Commission has allowed mobile terrestrial transmitters to operate on frequencies immediately adjacent to a satellite receive band. The proximity and adjacency of the WCS band to other sensitive radio services such as radio astronomy and air-flight telemetry also requires greater restrictions on mobile use of the band. As has been fully documented in the past, WCS licensees were well aware of these limitations when they acquired their licenses.⁷

II. Part 27 Rules.

The Ashburn tests and Sirius XM's various submissions during the course of this proceeding show that a number of factors working together will determine whether satellite radio service will be muted by mobile WCS operations. Each item below will need to be addressed in any revision of the Part 27 rules, and each will need to be analyzed and understood in relation to the other operational factors.

A. The Need for Guard Bands.

The satellite radio spectrum allocation lies between the two spectrum blocks allocated for WCS as shown below.



The C and D blocks are immediately adjacent to satellite radio receive bands and pose the greatest risk of interference to satellite reception. As WCS proponents have acknowledged, they cannot occupy the full 5 MHz available in these blocks and meet their proposed OOB limits of $55 + 10 \log P$.⁸ They have also admitted that a guard

⁷ See Reply Comments of XM Radio Inc., WT Docket No. 07-293, IB Docket No. 95-91 at 8-11 (filed March 17, 2008). In fact, not only was the Commission explicit in acknowledging the service limitations inherent in the WCS band OOB limit, but WCS licensees understood these limitations at the time of the initial WCS spectrum auction, which valued the entire WCS band at \$14 million, a fraction of the value of the satellite radio spectrum. *Id.* at 9.

⁸ See *Ex Parte* Letter from Jennifer M. McCarthy, Vice President, Regulatory Affairs, NextWave Wireless, Inc. to Marlene Dortch, Secretary, Federal Communications Commission at 3, IB Docket No. 95-91, WT Docket No. 07-293, GN Docket NO. 90-357 (submitted Nov. 26, 2008) ("This proposal with its stringent mask and reduced power

band will be necessary to help protect satellite radio consumers by testing to a 2.5 MHz guard band in their Ashburn demonstrations.⁹ Moreover, WCS licensees previously recommended limits on mobile use within 2 MHz of the satellite radio band edge.¹⁰ Sirius XM urges the Commission to maintain stringent restrictions on mobile uses in the C and D blocks, which could still be used for broadband purposes such as providing fixed broadband service and backhaul capability for mobile broadband service providers.

B. Duty Cycle.

Duty cycle is the percentage of time that a transmitter is actively transmitting. This parameter is often defined over some period of time, such as a transmission frame that is of sufficient duration to contain bursts from multiple users in a shared digital data stream. While most digital signal receivers can tolerate some loss of data within its digital signal frames without noticeable effect, short transmission bursts (*i.e.*, low duty cycle) will generally have a lower potential to cause significant impact than would longer duration transmission bursts.

The Ashburn tests showed that increasing the duty cycle of the WCS mobile device uplink aggravates the interference impact to satellite radio receivers. The following data was collected during the Ashburn tests.¹¹ Comparing the 6% duty cycle results to the 25% results shows that severe interference – in fact, *complete muting of the*

limits would effectively preclude use of the 2 MHz closest to the SDARS band edges, thereby limiting the utility of the WCS C and D blocks for two-way broadband applications”); *see also Ex Parte* Letter from Jennifer M. McCarthy, Vice President, Regulatory Affairs, NextWave Wireless, Inc. to Marlene Dortch, Secretary, Federal Communications Commission at 1-2, IB Docket No. 95-91, WT Docket No. 07-293, GN Docket NO. 90-357 (submitted Nov. 16, 2008).

⁹ *See Ex Parte* Letter from Mary N. O’Connor, Counsel to the WCS Coalition, to Marlene H. Dortch, Secretary, Federal Communications Commission at 2, IB Docket No. 95-91, WT Docket No. 07-293 (submitted August 4, 2009) (“It would be unrealistic to expect an operational WCS two-way broadband system to operate a full 5 MHz carrier in the C or D blocks because the filter required to meet the OOB limits is far too large to put in a mobile device.”)

¹⁰ *See Ex Parte* Letter from Jennifer M. McCarthy, Vice President, Regulatory Affairs, NextWave Wireless, Inc. to Marlene Dortch, Secretary, Federal Communications Commission at 3, IB Docket No. 95-91, WT Docket No. 07-293, GN Docket NO. 90-357 (submitted Nov. 26, 2008); *see also Ex Parte* Letter from Jennifer M. McCarthy, Vice President, Regulatory Affairs, NextWave Wireless, Inc. to Marlene Dortch, Secretary, Federal Communications Commission at 1-2, IB Docket No. 95-91, WT Docket No. 07-293, GN Docket NO. 90-357 (submitted Nov. 16, 2008).

¹¹ Engineering Appendix *attached to* Sirius XM August 3 *Ex Parte* at Exhibit A.

satellite signal carrying audio content – occurs at much lower power (by 14 dB) for the high duty cycle transmission than the lower duty cycle emission.¹²

	Duty Cycle		
	6%	12%	25%
WCS Channel Power at Sat. Radio Receiver, Required to Mute Sat. Radio Receiver (Dual Satellite Signal Reception Case) (dBm)	-42	-44	-56
WCS OOB Power at Sat. Radio Receiver (dBm/MHz)	-89	-91	-103

The data shows that even in the best-case, dual satellite signal reception conditions that would present lower interference potential, limiting the WCS uplink duty cycle between 6% and 12% helps mitigate interference from WCS mobile terminals operating in close proximity to satellite radio receivers. Higher duty cycle levels would require substantial reduction in the mobile transmit power levels within the WCS frequency blocks (*i.e.*, by 14 dB for the demonstrated case by going up from 6% to 25% burst rate) as well as OOB levels within the satellite radio frequencies.

Limiting duty cycle is also consistent with FCC precedent in general and the WCS rules in particular.¹³ Furthermore, such a restriction would not unduly hamper WCS commercial opportunities to expand broadband offerings to include mobile services. Although the WCS test set up at Ashburn was not fully transparent, the WCS licensees participating in the Ashburn tests did not appear to demonstrate any use case with mobile uplink duty cycles greater than that discussed here.

Based on the Ashburn tests, the Commission should adopt rules limiting WCS mobile device operations to a duty cycle of 6% or less. To provide further definition, a corresponding rule would require 300 microsecond pulses to occur no sooner than 5 milliseconds apart, a repetition rate based on the WiMAX frame rate. This approach and terminology is consistent with the provisions already contained in Section 27.53(a)(9)(i) of the Commission's Rules.

¹² Satellite radio reception was degraded during the tests before audio muting occurred. Such degradation can cause loss of data packet transmissions before causing loss of satellite radio audio service. In other situations or locations where the strength of the satellite signal is weaker than that experienced at Ashburn, the level of WCS interference receive will result in total muting. *See* discussion of satellite signal levels at 6 - 7, *infra*.

¹³ The current WCS rules already provide for relaxed OOB limits for certain classes of data devices that, among other things, limit duty cycle to 12.5%. *See* 47 C.F.R. § 27.53 (a)(9)(i).

Sirius XM emphasizes that this recommendation is based on the tests performed in Ashburn, which were conducted on WiMAX-based devices. While the framework of the recommendation may be appropriate for other types of mobile broadband technologies, further tests may be needed to verify the appropriateness of the recommended limits for other transmission technologies. For example, a repetition rate of 20 milliseconds may be appropriate for other advanced technologies that have longer frame rates than WiMAX.

C. OOB Limits.

1. Sirius XM Receivers Require More Protection From Out-of-Band Emissions Than Recommended By the WCS Interests.

WCS licensees participating in the Ashburn tests conducted certain use case demonstrations where the satellite radio's audio signal reception did not completely mute. These results do not validate the OOB emission's mask proposed by the WCS Coalition and used in the Ashburn tests because the same results would not have been achieved if the tests were performed in other parts of the country.

The Ashburn tests were conducted under "best case" conditions. For example, the WCS base station used for the tests provided an unconventionally small base station coverage area, and interference was created from only a single WCS user. The tests were conducted on wide streets with few buildings, trees or other obstructions to reduce the available satellite signal. Most particularly, the strong and uninterrupted satellite link margins available in Northern Virginia are among the strongest available anywhere in the United States. All of these factors worked to reduce the impact of WCS interference.

Not all satellite radio service areas offer such favorable operating conditions. Significantly different results can be expected in other areas of the country as satellite signal levels can vary by as much as 8 dB in different geographic regions. Attached to this letter is a map of the S-band transmit EIRP of one of the active XM satellites.¹⁴ This map shows that the Northern Virginia area falls near the 69 dBW EIRP level for the XM satellite. In contrast, south Florida lies near the 61 dBW EIRP level and thus receives signals 8 dB lower than Northern Virginia. In populated cities such as Miami and Houston, Sirius XM has less margin to overcome the link losses from interference, foliage and other obstructions, leaving satellite radio consumer receivers more susceptible to interference from WCS devices than in Ashburn, Virginia.

¹⁴ See XM Radio Inc., File Nos. SAT-RPL-20040212-00018 and SAT-RPL-20040212-00019, Appendix A at 11, Figure A-2 (granted Jan. 26, 2005). XM Radio Inc. subsequently modified some of the technical parameters of its satellites, but did not materially change the PFD contours of the XM-3 satellite. See XM Radio Inc., File No. SAT-MOD-20070912-00125, Narrative at 4, note 7 (granted Feb. 14, 2008).

At the Ashburn tests, WCS licensees demonstrated only a small fraction of the possible technology or use cases that would be permitted if their rule proposals were adopted. Even with such a controlled environment and best-case conditions, one of the seven WCS demonstrations showed complete satellite radio audio signal muting, and the other cases showed a significantly weakened satellite radio signal.

Sirius XM calculates that these reduced link margins require more than an additional 15 dB in OOB protection to protect satellite radio receivers in locations other than a Northern Virginia parking lot with no trees or obstructions to degrade the satellite signal.¹⁵ Adding this value to the WCS Coalition's OOB mask as applied to the satellite radio band edge would increase the required attenuation from $55 + 10 \log P$ to at least $70 + 10 \log P$. While this may be sufficient to protect against the limited number of use cases that the WCS licensees showed in Ashburn, additional protection is warranted to guard against all possible WCS configurations permitted by flexible WCS rules – unless the Commission adopts a full complement of WCS restrictions as proposed herein.

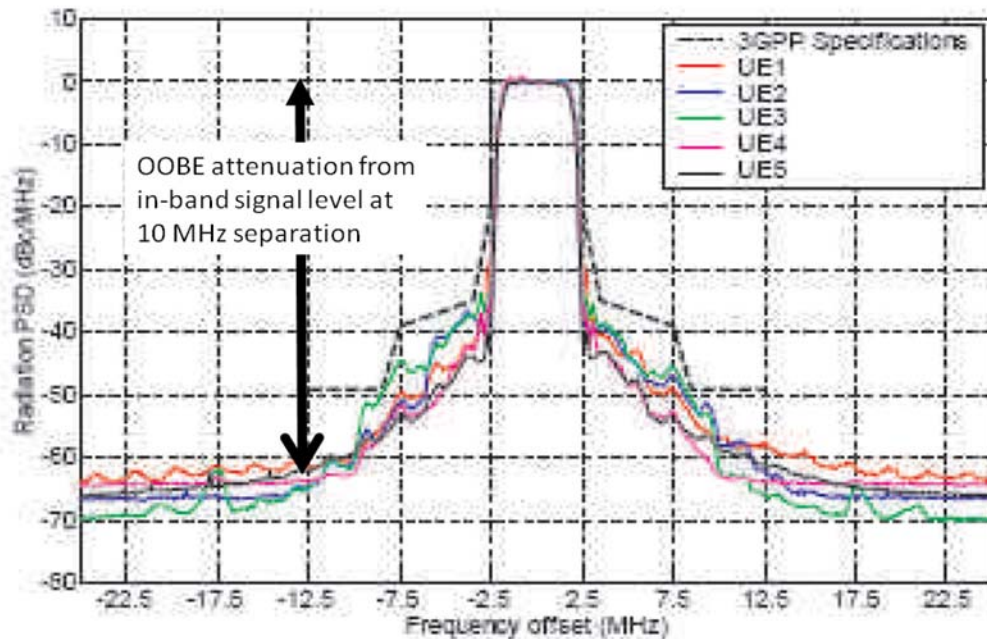
2. Current Technology Can Achieve the Level of OOB Attenuation Needed to Protect Sirius XM Receivers.

WCS devices can achieve higher levels of OOB attenuation with current technology than the levels WCS licensees claim. In the AWS-3 proceeding, the Commission considered emission profiles from five 3GPP user devices prepared by UK's OFCOM.¹⁶ This data helps establish the type of attenuation that can be expected from existing off-the-shelf technologies.

Sirius XM has “mapped” these profiles against the WCS and satellite radio allocations to demonstrate the relative attenuation of emissions that would be received in the satellite receive bands from these devices when operated in any of the various WCS blocks. This analysis is derived from the following graph:

¹⁵ These calculations are attached to this letter. See “OOB and Link Margin Calculations.”

¹⁶ See The FCC's Office of Engineering and Technology Releases Analysis of AWS-3 Interference Tests, *Public Notice*, 23 FCC Rcd 14669 (2008).



As shown in this graph:

- If this device operated in the lower WCS A Block (A1), its OOBE would be attenuated on average by 65 dB on frequencies occupied by Sirius TDM1 – the closest satellite receive band to the A1 spectrum block. OOBE would attenuate by an additional 2 or 3 dB on frequencies occupied by the inner Sirius satellite band (Sirius TDM2).
- If this device operated in the lower WCS B Block (B1), its OOBE would be attenuated by 52 dB on average on frequencies occupied by Sirius TDM1. OOBE would attenuate by an additional 13 dB on frequencies occupied by the inner Sirius satellite band (Sirius TDM2).
- If this device operated in the lower WCS C Block, its OOBE would be attenuated by 42 dB on average on frequencies occupied by Sirius TDM1. OOBE would attenuate by an additional 14 dB on frequencies occupied by the inner Sirius satellite band (Sirius TDM2).

This analysis shows that devices can provide higher levels of attenuation than the levels recommended by the WCS Coalition. For example, if the devices profiled by OFCOM were operating at 100 milliwatts in the lower B, their OOBE would satisfy an emissions mask of approximately $69 + 10 \log P$ at the Sirius XM band edge, within the first 1 MHz of the TDM1 satellite band. A similar device operating on the lower A block would satisfy an emissions mask of $82 + 10 \log P$ at the band edge.¹⁷ These levels would

¹⁷ To clarify, 100 mw transmit power over a 5 MHz WCS channel is equal to -10 dBW per 5 MHz, or -17 dBW over 1 MHz. The 3GPP device emissions figure indicates that B-lower block signal out of band emissions are attenuated by 52 dB by within the

be achieved by devices reviewed by OFCOM in 2008. This data demonstrates that WCS mobile devices operating in the A and B blocks can easily achieve OOB attenuation at levels up to and exceeding $70 + 10 \log P$ with little to no additional filtering for the A and B Block mobile uplink operations.¹⁸

D. Transmit Power Control.

While Sirius XM agrees that any change to WCS rules allowing mobile use should require WCS mobile devices to employ automatic power control, this parameter needs to be clearly defined in any modified rules to ensure the full value of interference protection. The WCS licensees' Ashburn demonstrations relied on the use of power control and confirmed that the technology is needed to protect satellite radio from interference. However, because the test set-up for the WCS licensees' demonstrations was not fully transparent, neither Sirius XM nor the Commission attendees could fully understand how transmitter power control was being implemented. Moreover, as noted above, the distance between the test WiMAX base station and the WCS prototype device was very short, which did not create an environment where the performance of the automatic power control technology could be fully tested.

Sirius XM, therefore, recommends that any rule changes to authorize WCS mobile devices should allow operations with transmit power up to 250 milliwatts but with transmit power exceeding 150 milliwatts no more than 10% of the time. To determine compliance with this requirement, the time frame should be defined as one second. Such a requirement will not hamper the commercial viability of mobile WCS services because WCS licensees have indicated on the record that WCS mobile terminals would need to transmit at 125 mw or less 99% of the time.¹⁹

first 1 MHz of the satellite radio band, to -69 dBW/MHz. This is equivalent to $69 + 10 \log P$ OOB mask level. Using the same analysis for a device operating in the A-lower block shows that -82 dBW/MHz emissions would fall within the satellite radio band is found, which is equivalent to an $82 + 10 \log P$ OOB mask.

¹⁸ Current rules require all WCS devices, including mobile devices, to limit OOB on frequencies below 2300 MHz to $70 + 10 \log P$ to protect radioastronomy operations. There has been no proposal to modify this limitation. This limitation requires mobile devices operating on the A1 block to attenuate OOB to that level after a 5 MHz guard band allocated for amateur radio services. This relationship would be similar to mobile WCS operations on the B1 block using the C block as a guard band to satellite radio services.

¹⁹ *Ex Parte* Letter from Jennifer M. McCarthy, Vice President, Regulatory Affairs, NextWave Wireless, Inc. to Marlene Dortch, Secretary, Federal Communications Commission at Attachment, p. 3, IB Docket No. 95-91, WT Docket No. 07-293, GN Docket NO. 90-357 (submitted Nov. 16, 2008) ("The WCS Coalition's study of transmit power control indicates that 99% of the time a device will transmit 3 dB below its maximum power level. Combined with the path loss isolation, WCS mobile transmission power levels will be significantly lower than the maximum allowed").

E. Other operational conditions.

Any revised rules should also: (a) define mobile device so as to allow only battery operated data card devices with integrated antennas; (b) prohibit mounted automotive or other mobile platform applications; and (c) require transmitting antennas to employ linear polarization or another polarization that provides equivalent of better discrimination with respect to a satellite radio antenna. All other technology neutral WCS operations should follow the current Part 27 rules.

Also, any revised WCS rules should include different downlink transmit power allowances for the frequencies adjacent to the satellite radio frequencies, (*i.e.*, the C and D blocks) and the non-adjacent (A and B blocks) for transmitters higher than 2W EIRP (measured as “burst average”) while continuing the existing OOB limits for WCS base stations. Additionally, limited MIMO and adaptive antenna systems should be allowed only if it does not exceed maximum limits in aggregate transmission power.

III. Part 25 Rules.

The current proceedings were initiated in 1995 to provide Sirius XM with final rules for the deployment of satellite radio terrestrial repeaters. Most of the recent focus in this docket, however, has been on the 2007 request of WCS licensees to offer mobile services in their frequency band. Regulatory procedures for deploying terrestrial repeaters with sufficient technical flexibility are critical to the success of satellite radio service and the lack of those rules has hindered Sirius XM.²⁰ Sirius XM urges the Commission to adopt the following regulatory framework to govern the construction and operation of satellite radio terrestrial repeaters:

- A blanket licensing process that allows for the deployment of compliant repeaters without further FCC authorization;
- New repeaters may operate with up to 12 kW EIRP;
- Existing repeaters operating with up to 25 kW EIRP shall be grandfathered; existing repeaters operating with more than 25 kW can continue operations based on FCC approval of a showing demonstrating little to no risk of interference and shall be allowed for replacement with substitutes at a nearby location when necessary, *i.e.* events requiring removal of the grandfathered site; and

²⁰ The Commission specifically recognized the need for terrestrial repeaters in its original decision adopting service rules for the satellite Digital Audio Radio Service spectrum. *See Establishment of Rules and Policies for the Digital Audio Radio Service in the 2310-2360 MHz Band*, Report and Order, Memorandum Opinion and Order, and Further Notice of Proposed Rulemaking, 12 FCC Rcd 575 (1997).

- OOBE shall be attenuated by $75+10\log(P)$ dB (measured in 1 MHz) with respect to the main carrier, where P is the average transmitter power in watts when measured at the output of the transmitter.

WCS receivers operate with at least a 4.2 MHz guard band from Sirius XM's terrestrial repeaters, with the A and B blocks more than 9.2 MHz removed. This separation renders the threat of interference from satellite radio repeaters to be quite low and WCS interests have submitted nothing in this proceeding that shows otherwise.

IV. Conclusion.

The Commission understood the challenge of allowing mobile operations in the WCS band when it first adopted WCS rules in 1997, and loosening those rules will require the Commission to create a unique set of technology-specific requirements in order to prevent mobile WCS transmitters from interfering with satellite radio reception. The rules proposed herein – all of which are needed to protect satellite radio reception – provide the interference protection mechanisms essential to allow co-existence between the satellite and mobile usage now proposed for this band.

While the current Part 27 rules allow flexible fixed broadband system deployments, any modification of these rules to allow mobile WCS devices should incorporate the operational rules and guidelines as discussed above. These parameters are all interrelated and should be addressed in a comprehensive manner. In order to protect satellite radio consumers, the Commission must:

- Continue to restrict mobile uses on the WCS C and D blocks.
- Limit duty cycle to 6 % or less in order to limit the extent of WCS interference.
- Maintain an OOBE mask of at least $70+10\log P$ or greater in order to replicate the WCS Coalition's Ashburn tests at other parts of the country. Even more stringent OOBE mask levels are necessary to properly address all interference cases that would be allowed if the WCS Coalition's proposed rules are adopted as submitted. Sirius XM has shown that available technology can achieve these levels of protection.
- Formulate a clear definition of transmitter power control.
- Restrict mobile operations to battery operated data card devices with integrated antennas and prohibit mounted automotive or other mobile platform applications.

The Commission should also adopt the long-overdue Part 25 rules discussed herein, allowing Sirius XM to construct and operate terrestrial repeaters that are needed in connection with satellite radio service and pose no threat to WCS interests.

Respectfully submitted,

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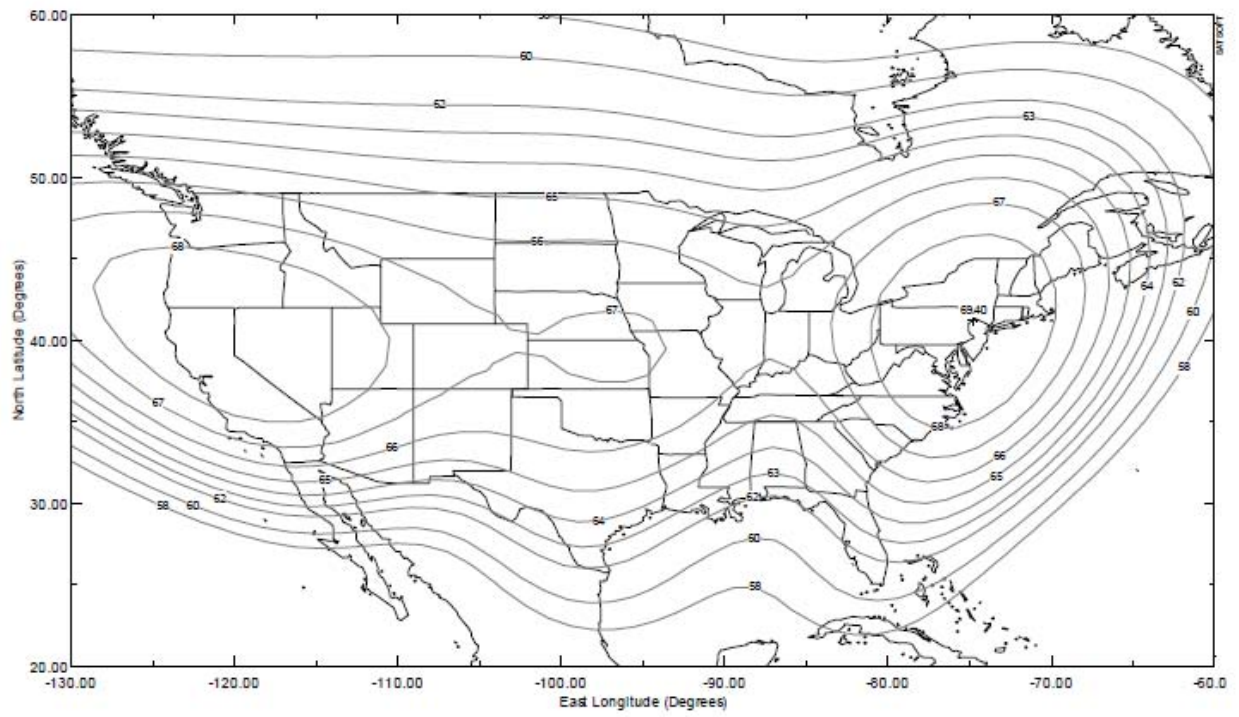
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Attachments

CC:

Julius Knapp
Robert Nelson
Roger Noel
Pat Forster
Tom Derenge
Moslem Sawez
Jay Jackson
Chip Fleming

S-band Transmit EIRP (dBW) Contours for XM-3 at 85°W



OOBE and Link Margin Calculations

The following data points are used to demonstrate the possible link margins available to Sirius XM receivers at various locations around the country.

	Satellite Signal Level (dBw)	Path Loss (dB)	Ground Signal Level (dBm)	Receiver Antenna Gain (dB)	Antenna Gain Fluctuation (dB)	Ground Losses (dB)	Signal level after antenna (dBm)
Ashburn, VA	69	191.34	-92.34	+3	-2	-2	-93.34
Miami, FL	61	191.14	-100.14	+3	-2	-2	-101.14

The Sirius XM aggregate system noise floor is -112 and -113 dBm in Ashburn, VA and Miami, FL, respectively, including noise contribution from the adjacent satellites and the antenna temperature from the considered local fading. The *signal to noise ratio* after the antenna is equal to the difference of the noise floor and the signal level delivered to the Sirius XM receiver after the antenna:

$$\begin{aligned}\text{Ashburn:} & \quad -93.34 \text{ dBm} - (-112 \text{ dBm}) = 18.66 \text{ dB} \\ \text{Miami:} & \quad -101.14 \text{ dBm} - (-113 \text{ dBm}) = 11.86 \text{ dB}\end{aligned}$$

Approximately 6.6 dB of the signal to noise ratio is required to demodulate a satellite radio signal. Thus, the remainder of the signal to noise ratio specifies the *link margin*:

$$\begin{aligned}\text{Ashburn:} & \quad 18.66 \text{ dB} - 6.6 \text{ dB} = 12.06 \text{ dB} \\ \text{Miami:} & \quad 11.86 \text{ dB} - 6.6 \text{ dB} = 5.26 \text{ dB}\end{aligned}$$

The overload interference from the WCS signal forces the satellite radio receiver's Automatic Gain Control (AGC) function to engage, which may reduce the desired satellite radio signal level by 5 dB as compared to the noise floor in various parts of the satellite radio's analog and digital circuitry, in order to accommodate the interfering overload signal in the available signal dynamic range. For the Ashburn location, this effect reduces the remaining link margin of the satellite radio receiver from 12.06 dB to 7.06 dB, in this examined case. When the simultaneously occurring interference from WCS OOBE raises the noise floor by 7.06 dB to result in zero link margin, this would result in complete muting of the satellite audio signal. The interference level that would increase the aggregate noise floor by 7.06 dB from -112 dBm to -104.94 dBm is -105.9 dBm (*i.e.*, $10^{-104.94/10} = 10^{-105.9/10} + 10^{-112/10}$).

If the same analysis is applied to a Miami, Florida, location, the 5 dB AGC impact from the same WCS transmit signal power would reduce the remaining link margin available to the satellite radio receiver from 5.26 dB to 0.26 dB. Any additional interference caused by WCS OOBE that would raise the noise floor by 0.26 dBm would result in complete muting of the satellite audio signal. The interference OOBE level that would increase the aggregate noise floor by 0.26 dB from -113 dBm to -112.74 dBm is -125.1 dBm (*i.e.*, $10^{-112.74/10} = 10^{-125.1/10} + 10^{-113/10}$).

The difference between the interference levels in Ashburn (-105.9 dBm) and southern Florida (-125.1 dBm) that would cause complete muting is 19.2 dB in this example. As a result, in order to replicate the WCS licensees' test cases performed in Ashburn, VA and using $55 + 10 \log P$ mask level, the WCS OOB E should be tighter by 19.2 dB.

At Ashburn, Sirius XM conducted additional tests that showed much greater interference conditions than those presented by the WCS licensees. The test cases presented by Sirius XM would be permitted under rules by the WCS Coalition and, if included in any new rules ultimately adopted by the Commission, would necessitate greater suppression of WCS OOB E to prevent interference to Sirius XM receivers. Also, Sirius XM's tests performed at Ashburn were premised on WiMAX-based WCS transmissions. Further tests may be needed to accurately establish the required level of OOB E suppression for alternative mobile technologies.